Efforts to Restore Water Balance by Water Budgeting Through Community Participation

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Preamble

The demand for water in all sectors is increasing day-by-day and maintaining supply of water to meet the increasing demand is becoming a tedious job and a costly affair. The increase in demand of water is not only for Agriculture, but also for household, buildings, commercial and industrial purposes. It is estimated that water needs for drinking and other municipal uses will increase from 3.3 MHm to 7.00 MHm in 2020-25. Similarly the demand of water for industries will increase by 4 fold i.e. from 3.0 MHm to 12.00 MHm during this period.

Lot of efforts have been made by the government and concerned agencies to plan the water supply by water harvesting, conservation and artificial recharge and by improving the water supply infrastructure.

However, more focus has been on bridging the demand and supply gap, without giving the due emphasis on water resource assessment, aquifer parameters and surface water availability in totality. The truth of this statement is substantiated by the fact that the water as a commodity is being considered a freebie in India resulting in its misuse. Degradation in groundwater quality and depletion of water levels is another indicator of mismanagement of the resource as a whole.

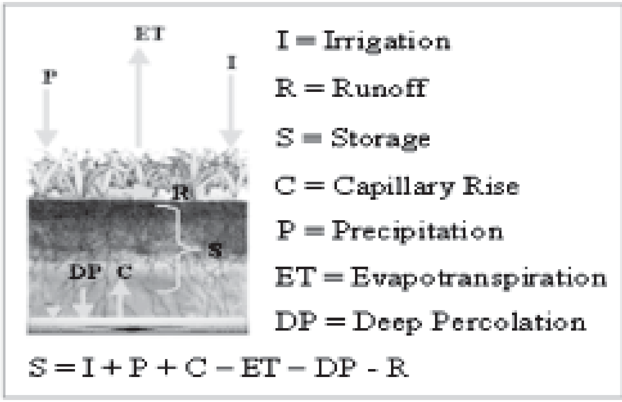
Emphasis on water resource assessment is the need of the hour to plan the water resource management. This essentially requires assessment of:

1. Availability, 2. Usage and 3. Balance

Assessment of available water resource and its usage only can give the status of water balance. After getting the water balance one can prepare the water budget of an area and plan the resource usage and thereby enforce effective water resource management.

Water Budget

Water budgeting reflects a balance between the inputs and outputs of water to and from the plant root zone. The method is similar to balancing a checkbook. Water budgeting inputs include precipitation, irrigation, dew, and capillary rise from ground water. The outputs include evapotranspiration, runoff, and deep percolation.



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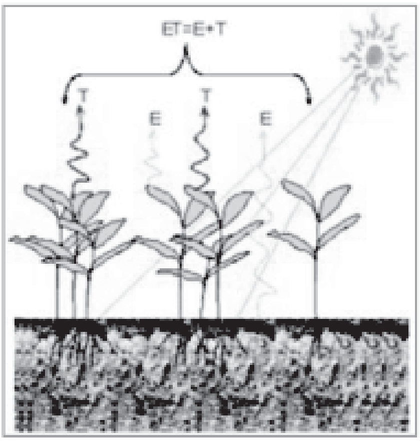
Evapotranspiration (ET) is the term used to describe the loss of water to the atmosphere by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues).

As described above, three conditions must be met for ET to take place. First, water has to be present at the surface-atmosphere interface. Second, there must be some form of energy, which is usually provided by the sun, to convert the liquid water into a water vapor. Third, there must be a mechanism to transport the water vapor away from the evaporating surface.



Runoff and deep percolation can be estimated based on local factors such as soil properties and slope. Dew formation and capillary rise of ground water can also be estimated. However, estimation of the latter two parameters is a bit involved. Fortunately, these values are relatively small (depending on the specific situation) and can be ignored for most practical purposes. There are several tools and resources that an irrigator can utilize in order to estimate these parameters and schedule his/her irrigation needs.

Water Balance

Water balance serves as an effective tool to assess the current status of water resource availability of an area and thereby helps to develop vision and strategy for water management decision making at stakeholder level.

A general water balance equation is:

$$P = Q + E + \Delta S$$

Where

P	is precipitation
Q	is runoff
E	is Evapotranspiration
ΔS	is the change in storage (in soil or the bedrock)

This equation uses the principles of conservation of mass in a closed system, whereby any water entering a system (via precipitation), must be transferred into either evaporation, surface runoff (eventually reaching the channel and leaving in the form of river discharge), or stored in the ground. This equation requires the system to be closed, and where it isn't (for example when surface runoff contributes to a different basin), this must be taken into account. This can be simply put as an assumption that water entering an area has to leave the area or be stored in it.

For practical purposes water is divided in to two parts:

1. Green water that is retained as soil moisture and evaporates in to the atmosphere.
2. Blue water that is available for use in various sectors like irrigation in the form of surface and groundwater.

A water balance can be used to help manage water supply and predict where there may be water shortages. Several water balance models have been developed for several conditions and purposes. However, generalized assessment of water balance requires:

a. Delineate the area of interest preferably on the basis of watershed and define the time period over which water balance is to be made.

b. Assess the need of disseminating water balance information among the stakeholders. This will help customize the components of water balance that are of particular interest in the area.

c. Represent the area in simple maps and schematic diagrams to show the storage, inflows and outflows from the area.

d. Collect secondary data relevant to the area like population, cropping methods, soil data etc.

e. Analyze the data and information collected on quality and reliability parameters

f. Develop simple tools to assimilate information to produce water balance estimates in coordination with the stakeholder/community.

g. Water balance estimates shall be presented in formats that help community in capacity building, vision, planning and decision making.

Following temporal and spatial data may be required for water balance:

- Rainfall data
- Land use and cropping pattern data
- River, Tank and Canal data
- Aquifer parameters,
- Water level data and
- Groundwater withdrawal

By estimating the inflow / outflow of a defined hydrological unit one can determine the components or a component that has maximum effect on the water resource regime of that area.

Shortcomings

a. Temporal and spatial boundaries cannot be defined appropriately,

b. The input data quality may be poor,

c. Water flows entering or exiting from a system may be doubly added or excluded,

d. Hydrological data is time and space dependent and hence inappropriate extrapolation of data may take place.

Status of Gujarat

After the bifurcation of the Gujarat state from Maharashtra in 1960 rapid industrial development and goals set to achieve self sufficiency in fields of food, dairy, energy, health, etc resulted in extensive development of water resources in the state.

The agriculture sector, accounts for about 85 to 90% of total water demand with the subsidized supply of power (Horse-power based) resulting in the over-exploitation. The high resource cost for industries, on the other hand, cross-subsidizes the water consumed by the other sectors.

The demand of fresh water across various sectors has been assessed at about 518 BCM in 1990, which with continuing trend is expected to go up to 1422 BCM BY 2050. This will be much in excess of the total utilizable average water resources of 1086 BCM (Patel Dr. A.S.).

Ground Water Development IN Gujarat

First working committee "Group for estimation of ground water resources and Irrigation potential" for the estimation of ground water resources was appointed in May 1985 and first report was submitted by the committee in April, 1986. The re-estimation is being done at the interval of 5 years as per the directions of Government of India. Accordingly, the revision in the assessment was carried out for the base years 1991, 1997 and 2002. The assessment for the year 2002 was updated for the year 2004 and incorporated in the report entitled "Dynamic Ground water resources of Gujarat"

The report up to March 2009 was published in December 2010. Similarly, report of March 2011 was published in 2014. District wise groundwater development in Gujarat from 1984 to 2011 is depicted in the following table which is based on the number of talukas:

Year	1984	1991	1997	2002	2009	2011
White	162	121	95	123	56	171
Semi- critical	13	26	43	40	20	13
Critical	6	10	8	6	6	5
Over exploited	1	24	31	41	27	24
Saline	1	2	7	13	14	10

(Source- GWRE and reports on Dynamic GW Resources of Gujarat state published by CGWB and GWRDC time to time)

In last two decades some new districts and talukas were formed that has resulted in change in numbers of talukas.

Central Ground Water Board has set up nearly 1100 observation wells in Gujarat state which are regularly monitored to evaluate the ground water balance, quality, etc.

Rainfall pattern and Ground water development: Gujarat has large variation in rainfall pattern. North Gujarat region receives very less rainfall compared to Central and South Gujarat. Decadal comparison of North, Central, South and Saurashtra rainfall (in mm) for three decades is as under:

Region	1981-1990	1991-2000	2001-2010
North Gujarat	606	663	615
Central Gujarat	820	726	817
South Gujarat	1510	1616	1684
Saurashtra	609	524	788

Due to good rainfall in last decade and water harvesting and recharge measures undertaken in state, the ground water condition has improved but simultaneously pumping of groundwater also increased. As per GWRE 2004 and 2011 the ground water extraction structures used for irrigation were as below:

Region	2004	2011	Difference	% Increase
North Gujarat and Kutch	211531	264915	53420	25
Central Gujarat	65776	83341	17565	27
South Gujarat	65189	85391	20202	31
Saurashtra	317986	450372	132386	42

The above data reveals that the increase in ground water extraction structures was more in Saurashtra (41.63%) and South Gujarat (30.98%). The decadal average of rain was also more than the average of last two decades. The study of rainfall pattern, groundwater pumping and the ground water development which directly affects the potential of aquifers reveal that due to good rainfall and acceptance of recharge practices have improved the condition of Ground water development during last decade.

Other Factors affecting Ground water Potential and Development

1. Water market
2. Subsidies
3. Water rights v/s land rights
4. Dairy development
5. Lack of awareness about the resources
6. Political interference
7. Agricultural practices
8. Use of more fertilizers.

Need:

- Self regulation, IEC, Capacity building
- Effective Legislation and delink the water rights and land rights
- Community participation
- Water budgeting
- Change in irrigation system

Water Security through Water Budgeting in Kheralu Block of Mehsana district

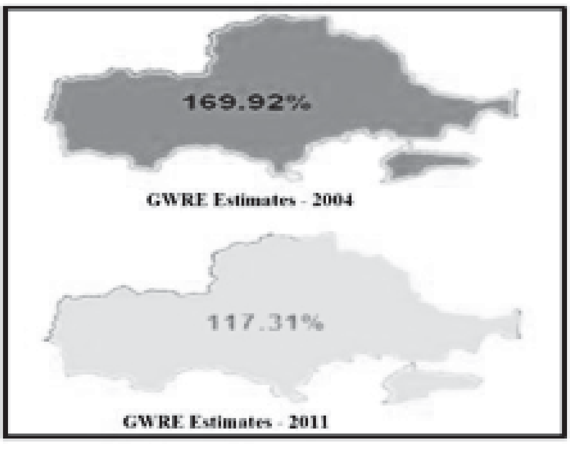
Through Government of India initiative it was decided to select this over-exploited block as pilot for implementation of convergent action for sustainability and panchayats monitoring and management of water resources to achieve Drinking Water Security.

Pilot Program Objective

Main objective is to achieve Drinking Water Security in a holistic manner. This pilots in addition to achieve drinking water security is expected to demonstrate different dimensions of water security, which include cost of investments, setting up of minimum standards for pricing, Quality & quantity assurance, groundwater resource management, capacity building & training.

Groundwater Development of the block

Groundwater development estimated by GWRE is 169.92% as per estimates of year 2004 and some improvement (117.31%) is observed as per draft estimates of 2011. Groundwater development has shown improvement as per recent reporting. This improvement is due to efforts made in water Conservation, Harvesting & Recharge by various Govt. agencies. The improvement is a cumulative effect WRM activity carried out by the Govt. of Gujarat and a decade of relatively better monsoon.



Status of present water supply

Hydro-geologically the area is represented by loose alluvium underlain by Granitic formation. The depth to bed rock varies with increase in depth from North East to South West part of the block, which also is the general slope direction of the area. Recharge condition of the area is good with an overall infiltration rate of 24%.

Water levels vary from 15 Mts. in the eastern part to 100 Mts. in South western part. Yield also varies from 8000 LPH to 80000 LPH in the block. Most of the open wells in the block have dried up. Major use of groundwater is for agricultural purposes. Industrial use for groundwater is minimal. Ground water quality is also deteriorated in most of the villages as groundwater sources developed for drinking purposes in around 20 villages are non potable. Major factor affecting the groundwater quality is Fluoride. Though groundwater based sources have been developed for all villages, yet in view of the quality issues the whole taluka has been covered under Dharoi dam based Regional Water Supply Scheme.

Pani Samitis are active in all the 52 villages of the block and all villages have been covered under household tap connections. However, it has been observed that due to mismanagement and lack of awareness equity supply up to the tail end households has not been established. In spite of moderate to adequate water supply available water supply to households is erratic.

Groundwater use in agriculture is in excess of the water required for irrigation. Mostly flood irrigation is being practiced in whole block, which is a major cause of dwindling groundwater resources.

Salient features of Kheralu block

Geographical Area (Hectares):	33757
Average rainfall (mm):	712
Annual Groundwater Recharge:	8528 Hectare Meter
Total Annual water withdrawal:	10105 Hectare Meter
Annual Deficit:	1577 Hectare Meter
Groundwater Development:	169% as per 2002 estimates
Hydro-geology:	Alluvium underlain by Granite
Groundwater Quality:	Excessive Fluoride in around 20 villages
Water levels:	15 to 100 Mts.
Average yield:	8000 - 80000 LPH
Water Supply:	Tube wells & Dharoi Dam based scheme
Irrigation Practices:	Mainly flood irrigation

Methodology adopted

To achieve water security it is necessary to implement approach of participatory planning and implementation at community level. The main objective is to encourage the community to prepare their village wise water budget for attaining water security.

The role of the administrator has been defined as the working interface of scientific knowledge and use of technology & equipment, which is explained to the user in very simple forms.

The role of the **Administration/Facilitator** is defined as under:

- Know the stake holder well and respond to his thought process
- Interested subject shall be given access to critical information
- Impart knowledge and skill to the end user in simplistic manner
- Plan decentralized Unity- Activity at cluster level & decision making after analysis of data at block level
- Change the perception of GW user to match usage with availability
- Demystify Science & Technology at user level

- Train the community to collect the technical data
- Reallocate investment to community through convergence
- Engage community to deliberate on collected data
- Identify appropriate water use system in consultation with user
- Formulate incentives and incentive building process
- Develop market intelligence and revenue generation models.
- Emphasis on Economics of water
- Technical support to community for data analysis

The role of **the stake holder/ end user** is defined as under:

- Adopt scientific know how, technology and innovations
- Learn how to collect data and motivate others also to collect data
- Deliberate at community level on collected data
- Create pressure groups for effective water use
- Give equal representation to genders
- Involve all including poor to reach at a democratic decision
- Train others after being trained
- Manage optimal usage of water resource so that there is always some surplus
- Develop self regulations for water use and sanitation
- Initiate energy saving, improved sanitation, common animal hostels etc.
- Learn about low water consuming but Revenue rich crops
- Adopt water harvesting, Recharge & modern irrigation practices
- Record the collected data & also display it at common community centers
- Make decision collectively after analyzing the data

Technical Requirements

- Delineate Hydrological Units
- Motivate community to collect technical Data
- Establish Rain Gauge stations & observation wells
- Inventory of all resources and pumping units
- Study of Cropping patterns
- Explain GW concept and availability to users
- Help community to prepare water balance at village level

- Train community for water budgeting procedures
- Help community to frame committees for effective implementation

Role of Operational Group

The operational group in this pilot project is Water Supply Department along with the district core group and the user group is the community of Kheralu taluka at grass root level. Implementation proceeds as tabulated below:

<table>
<tr><th colspan="3">Operational Group</th><th colspan="3">User group</th></tr>
<tr><td colspan="3">Estimation of</td><td colspan="3">Data Collection of</td></tr>
<tr><td>Runoff</td><td>GW Draft</td><td>GW Recharge</td><td>No. of sources</td><td>Water levels</td><td>Discharge</td></tr>
<tr><td colspan="3">Water Balance</td><td colspan="3">Average pumping Hours</td></tr>
<tr><td colspan="6">Joint Analysis</td></tr>
<tr><td colspan="3">Recommend</td><td colspan="3">Observe/follow</td></tr>
<tr><td>Pumping pattern</td><td>Recharge methods</td><td>Crop Water Budgeting</td><td>Crop Water Budgeting</td><td>Modern Irrigation</td><td>WRM</td></tr>
<tr><td colspan="6">Device Effective Cropping pattern, WRM, Sanitation & Trainings</td></tr>
</table>

GWSSB and WASMO have taken up the pilot project jointly. WASMO functions as the main support organization. Recharge Cell of GWSSB looks in to the technical aspects and water harvesting, recharge & conservation plan of the pilot. Pani Samitis serve as the subsidiary Support organization for implementation of Water security and sanitation plan in the block.

Association of all concerned Agencies (Core Group)

For effective implementation of water budgeting in the taluka it is important for the project implementing agency **(GWSSB & WASMO)** to coordinate with all concerned organizations for a holistic approach. For effective implementation **District Core Group, headed by district Collector** has been formed. Group in addition to GWSSB & WASMO, constitutes of the following members :

1. District Development Officer
2. Regional director, (CGWB)
3. Director, BISAG-State Remote Sensing Centre

4. Director, District Rural Development Agency (DRDA)
5. Director, Krishi vighyan Kendra, Ganpat University, Kherwa
6. Deputy Director Watershed- Mehsana
7. District Agricultural Officer
8. District Horticulture Officer
9. District Animal Husbandry Officer
10. District Primary Education Officer
11. District Health Officer
12. Executive Engineer, Dharoi water supply
13. Executive Engineer, Irrigation, Panchayat
14. D F O - Mehsana (Forest)
15. Gujarat Green Revolution Company (GGRC)

District Collector is the Chairman of the core group and Member Secretary DWSC-Mehsana is the member secretary of the core group.

Convergence across various departments envisages implementation of scientific technique, better approach, defined role of govt. agencies and mass awareness about water budgeting.

Under the Kheralu pilot project, 3 day training cum workshop for community is organized in each village to initiate the community for the process. First such workshop was organized at village Chada, in coordination with the World Bank team.

The objective of the workshop was to sensitize the village volunteers on:

- Safety of drinking water supply system,
- Assessment of water supplied, wastages and shortcomings of the system,
- Assessment of quality & quantity of water available within the village,
- Water levels, Storage and Aquifer management,
- Demand side management,
- Water Budgeting/Balancing
- Capacity building and training &
- Create trainers for the pilot program.

Methodology adopted

The meet was organized within the village Chada. Prior to this workshop a Gram Sabha had been conducted, to generate the awareness about the project, which was followed by an exposure visit to village Takhatgarh of Prantij taluka. They were exposed to the benefits of drip irrigation and common animal hostel.

The workshop was attended by 22 volunteers (including 9 female members) of the village. Officers from World Bank, DDWS-GOI and Water Supply Department coordinated to conduct the workshop.

The team of volunteers introduced themselves and gave their point of view on overall status of water availability in their village. It was observed that they had a fair knowledge about the Hydrogeology and Agronomy of their village. The volunteers were encouraged to provide the details about:

1. Their drinking water supply system,
2. Their agricultural practices & Cropping pattern,
3. Water consumed for irrigating crops,
4. Water requirement for domestic purposes,
5. Wastage of water supplied, etc.

To make the volunteers realize the importance of water budgeting, they were asked to prepare budgets for marriages, assess the income of village from agriculture, in addition to exercises that were meant to sensitize them for future course of action. All the volunteers were encouraged to provide the details of the village to the best of their knowledge. They deliberated on various issues within themselves before finalizing the information set assigned to them as individual groups.

Six different groups visited different localities within their village to make an assessment of their water supply system and general sanitation. The groups were given various exercises to seek information from them, before taking a step towards the concept of water budgeting.

Following major details emerged out of group exercise of volunteers:

A. Canal passing through the villages is 4300 Mts. in length and holds 34 cubic meters of water per meter length.

B. They during the field visit on day two were asked to measure the static water levels (SWL) and pumping water levels (PWL) in various sources and deliberate on it. They along with local farmers explained the fluctuation of water levels within the village and drop in water levels over the past two decades.

C. For water balancing purpose one group was given the task of presenting the details of groundwater based sources, which is tabulated below. Village water supply scheme tank of the village has a capacity of 50,000 liters. Therefore, all the calculations during the workshop, for easy understanding of village volunteers, are made in the form of tanks. (Unit of 1 Tank=50,000 liters)

Details of Groundwater based sources in village Chada				
		Total	Working	Defunct
1	Open wells /DCB	137	127	10
2	Bore wells	47	39	8
3	Average pumping water level		22.00	Mts.
4	Average depth of sources		35.00	Mts.
5	Static water level of the area		8.00	Mts.
6	Pumping machinery		5 to 7.5	HP
7	Average Discharge		6250	LPH
8	Pumping Hours		8	Hours /day
9	Average Water pumped/source		50000	LPD(**1Tank/day)**
10	Total water pumped out		166	Tanks/Day
11	Pumping Days		300	Days/ year
12	Water Pumped out annually		**49800**	**Tanks/ year**

D. The overall agricultural income generated in the village is around Rs. 1 crore per year.

E. It was calculated by the volunteers that 2011 animals (livestock) within the village require 663 tanks of water annually

F. Female group was particularly given the task of assessing the water requirements at domestic level for activities like drinking, washing, cooking, etc, which they calculated at 79 LPCD.

G. Major crops sown in the village are: Cotton, Castor, Millet, Wheat, Fennel, Groundnut, Pulses, Sorghum (Jowar), Mustard, Tobacco, Potato, Cattle feed.

H. Water requirement for agriculture was calculated as:

Water Required for Agriculture	Tanks/Year
Khariff	**4800**
Rabi	**33915**
Summer	**18300**
Total	**57015**
Water Supplied from:	**Tanks/Year**
Groundwater sources (300 days)	49800*
Canal supply	7862
Total	**57662**
***(647 for cattle + 49153 for irrigation)**	

I. Overall water requirement for various purposes was defined as:

Water use	Tanks / year				
	Required	**Supplied**	**GW**	**Canal**	**Total**
Irrigation	57015	57015	49153	7862	57015
Water Supply Scheme	1188	1460**	1188		1188
Water Supply Scheme wastage	0	0	256		256
Cattle	663	663	663		663
Total	**58866**	**59122**	**51260**	**7862**	**59122**
****16 tanks for cattle (647+16=663 consumption by cattle)**					

j. **Water Balance** was calculated from the details that emerged from the deliberations after the assignment of group tasks to volunteers.

Calculation of Rainwater availability			
Area of the village (767 Hectare)	7670000 M^2	Rainfall	600mm
Rainwater availability	4602000M^3	92040	Tanks
Percolation as Groundwater @ 20%	920400 M^3	**18408**	**Tanks**
Calculation of Canal water availability			
Canal length within village	4300 M	Water / meter	34 M^3
Annual water available (4300x34) =	146200 M^3	2924	Tanks
Recharge by Canal Water @10%	14620 M^3	292	Tanks
Canal water used for irrigation	393100 M^3	**7862**	**Tanks**
Calculation of Return flow from Irrigation			
Water used for irrigation	2850750 M^3	57015	Tanks
Percolation as return flow @ 20%	570150 M^3	**11403**	**Tanks**

Calculation of Water Balance for village Chada					
Total water available			**Total water consumed**		
From Rainfall	18408	Tanks	Irrigation	57015	Tanks
Recharge by canal	292	Tanks	Drinking & Domestic Water Supply	1188	Tanks
Direct Canal irrigation	7862	Tanks	Water Supply wastage	256	Tanks
Irrigation Return flow	11403	Tanks	cattle	663	Tanks
Total availability	**37965**	**Tanks**	**Total Consumption**	**59122**	**Tanks**
			Overall Consumption	**156**	**%**
			Water Balance	**-21157**	**Tanks**
Inference - Over-Exploited					

Impact of the workshop:

- The objective of sensitizing the village volunteers was achieved to a large extent.
- Perception of Govt. as provider got changed to facilitator.
- Volunteers realized that they have to take steps, as responsible users, to reverse the trend of over exploitation.
- Volunteers were keen on taking immediate steps to curb the water wastages within the water supply system as first step towards the water budgeting.
- They held a meet immediately after the workshop and decided to curb wastage at domestic level by providing taps , wherever required
- They expressed their keenness to know more about crop water budgeting and modern irrigation practices.
- The group felt the need to create water security through water budgeting.
- Water Supply Department assured them of full technical support in their resolve.

This type of activity along with rigorous social mobilizing has been conducted in all the 52 block villages, with emphasis on awareness & focus on behavioural change.

First Phase Work under Pilot Project has been completed. Broad based achievement so far is:

1. Regular rainfall data collection since 2011 in 11 clusters.
2. Base line data has been collected from all 52 villages.
3. Water balance/budgeting exercises in all the villages have been completed.
4. Most of the Villages have repaired leakages, put taps on the connections, initiated self regulations, and adopted drip irrigations, changed crops.

Sr. no.	Village	workshop Date	Water use	Sr. no.	Village	workshop Date	Water use
1	Amarpura	Jan-13	125%	27	Malekpura	Jul-14	176%
2	Ambavada	Feb-14	166%	28	Mandali	Oct-14	158%
3	Arthi	Dec-14	313%	29	Mandropur	Jan-13	214%
4	Ballad	Jun-14	230%	30	Mehkubpura	Dec-12	230%
5	Chada	Oct-10	156%	31	Miyasana	Dec-14	226%
6	Chanchariya	Nov-14	148%	32	Moti Hirwani	Nov-14	134%
7	Chansol	Feb-12	176%	33	Nalu	Jun-13	285%
8	Chotiya	Feb-14	186%	34	Nandali	Jan-13	199%
9	Dabhad	Aug-12	183%	35	Nani Hirwani	Jul-14	135%
10	Dabhoda	Feb-15	188%	36	Nani vada	Oct-14	210%
11	Dalisana	Dec-12	156%	37	Nortol	Mar-12	203%
12	Davol	Aug-12	295%	38	Panchha	Feb-13	244%
13	Dedasan	Jan-13	191%	39	Rasoolpur	May-12	118%
14	Delvada	Jun-14	252%	40	Rehmanpura	Feb-14	151%
15	Fatepura	Sep-13	122%	41	Sadikpura	Nov-14	253%
16	Gajipur	Jan-14	160%	42	Sagathala	Nov-14	363%
17	Gathaman	Jul-14	248%	43	Sakri	Jun-12	257%
18	Gorisana	Nov-14	264%	44	Samoja	Aug-14	154%
19	Kuda	Feb-14	309%	45	Santokpura	Jan-14	177%
20	Lalavada	Jul-13	297%	46	Suvaria	Jul-14	181%
21	Limbdi	Dec-14	216%	47	Thangana	Oct-14	175%
22	Lunva	Feb-14	292%	48	Unad	Sep-14	83%
23	Machhava	Jul-14	125%	49	Vagvadi	Jan-12	167%
24	Madasana	Oct-13	158%	50	Varetha	Sep-12	332%
25	Mahiyal	Jan-12	234%	51	Vavdi	Jun-14	155%
26	Malarpura	Mar-14	255%	52	Vithoda	Sep-14	198%

5. Water Level indicators and discharge measuring equipment has been allocated to all villages and data collection has begun.
6. More than 5000 toilets have been constructed since March 2013.
7. Village Fatepura, Sadikpura, Rasulpur & Nandali, Chanchariya have achieved ODF status. Facilitation for providing NBA funds is being done by coordinating with NBA.
8. In many villages Soak pits have been dug to improve sanitation. Other villages are also being encouraged for the same. Village cleanliness drives have initiated in most of the villages.
9. VWSC members - all 52 VWSC have been revived and reformed. More than 500 volunteers of pani samities have been trained.

10. More than 4000 Hectares of agricultural land has been covered under drip irrigation, thereby reducing stress on groundwater
11. Farmers have made changes in crops and started growing low water consuming cash rich crops.
12. Recharge activity carried out has resulted in water level and quality improvement.
13. Deepening of ponds in convergence with other departments and filling of ponds with Narmada ponds has resulted in revival of dried up wells.

The water balance/ budgeting activity carried out with community participation has resulted in overall improvement in water resource management at stakeholder level. The process if replicated in other areas will benefit the aquifer system and thereby the end user.

References :

Thatte Dr. CD: - Water scenario in India and Gujarat for food, energy and water scarcity

Patel Dr.AS, Shah Dr. DL: - Water Management Conservation Harvesting and artificial recharge.

CGWB and GWRDC: - Report on Dynamic Ground water Resources of Gujarat State (March 2004 & 2011).

Jain RC: - Groundwater Development Scenario and Emerging trends in Gujarat.

Phansalkar Dr. Sanjiv: - Challenges of managing water requirement of Dairy Industry in Gujarat.

Sherasia Dr. RA, Maraviya RB: - Gujarat's Agriculture- Present and Future water requirements.